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AUSTRALIA’S FIRST 6-STAR GREEN EDUCATION BUILDING: DESIGN AND PERFORMANCE

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Abstract

Bond University's Mirvac School of Sustainable Development is one where planning, property, project management, construction management and quantity surveying are integrated in a school of the urban environment in the context of sustainable development. The School is the first designated institute to fully integrate environmental, urban planning, property development, quantity surveying, construction management and facilities management disciplines with the practical issues of managing economic and social viability with societal expectations.

The goal was to blend together these three aspects: ecological sustainability – *indoor environment quality, transport, water, materials, emissions, land use and ecology* - closely linked to economic and social sustainability.

The building’s optimum orientation maximises solar gain and the capture of prevailing breezes. All offices have operable internal and external windows to promote cross-ventilation, and ceiling fans reduce the demand for air conditioning, a major consumer of energy. When outdoor conditions are optimum the Mirvac School of Sustainable Development utilises a ‘natural ventilation mode’; the building’s management system senses favourable outdoor conditions and ceases operation of the air conditioning plant and building occupants open their windows to control air temperature and movement to achieve thermal comfort.

The three-storey building with central corridors on office floors has light wells and natural ventilation. The orientation of the building is on a long axis east – west. This is the optimum orientation to maximise natural daylight and capture prevailing breezes. The construction is a lightweight façade. The building spaces – three studios, one CAD/GIS room, two research rooms, 32 offices, four meeting rooms, one ‘*Living Laboratory’*, covered outdoor teaching and recreation spaces.

1. The Green-Star Rating System

The Green Star Rating system is a comprehensive, national, voluntary environmental rating scheme that evaluates the environmental design and achievements of buildings. It was developed by and is administered by the not-for-profit organisation the “Green Building Council of Australia” (GBCA, 2008).

Green Star was developed for the property industry in order to establish a common language; set a standard of measurement for green buildings; promote integrated, whole-building design; recognise environmental leadership; identify building life-cycle impacts; and raise awareness of green building benefits.

Green Star covers a number of categories that assess the environmental impact that is a direct consequence of a projects site selection, design, construction and maintenance. The nine categories included within all Green Star rating tools are management; indoor environment quality; energy; transport; water; materials; land use and ecology; emissions and innovation. The 6 Star Green Star Certified Rating (score 75-100) signifies 'World Leadership'

The Bond University Mirvac School of Sustainable Development is registered under the Green Star Education PILOT rating tool. The Bond University Mirvac School of Sustainable Development has been awarded a 6 star rating under the Green Star Education PILOT rating tool. This is the first education project

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in Australia to be awarded a 6 star 'World Leadership' rating. The building was officially opened on the 11th August 2008. The completed building is shown in photograph 1.

Photograph 1
Entrance to the Building

Source: Mirvac

2. The Brief

The brief was developed by the design team and the stakeholders in a series of workshops. A primary aim of the project was to look beyond the various star rating systems and to target the 'Worlds Best Practice' in social, economic and environmental sustainability.

The intention was to make the various spaces comfortable all year round in this sub-tropical climate and to make the systems simple to operate and control by the users. The educational focus was to be the ' Living laboratory', a new form of community building integrated with the University and with the community for joint use. There was also recognition of the Bond University 'Culture', one that encourages interaction, accessibility and the need to provide a unique gathering space on a campus that is both functional and visually impressive. There was also a commitment by Mirvac, not only to Bond University but also to the long-term investment in the next generation of students who will develop an invaluable understanding of the growing importance of sustainability.

The building aims to fully integrate environmental, urban planning and architectural disciplines with the practical issues of financial viability and social expectation. The School's building has been designed and constructed to incorporate attributes consistent with world leadership in ecologically sustainable development.

The process and program for the design, construction and achievement of Green Rating took over two and half years (30 months) and the major stages are shown in Table 1.

Table 1 The Process and Program

Activity	Time Period	Activity	Time Period
• Research + Consultant Briefing	Feb2006	• Construction commenced	June 2007
• Sustainability and Concept Workshops	March 2006	• Green Star Round 1 submission	Oct 2007
• Design Development complete	Oct 2006	• Green Star Round 2 submission	May 2008
• Construction Documentation commenced	Nov 2006	• Construction complete	June 2008
• Site works commenced	Jan 2007	• Green Star Education PILOT 6 Star	June 2008
• Green Star Education PILOT released	May 2007	• Handover and Occupation	July 2008

3. Indoor Air Quality

Indoor Environment Quality describes the characteristics of the indoor climate of a building. It covers aspects such as temperature, humidity, levels of fresh air and natural light. Improving the indoor environment quality can lead to energy saving, occupant health and productivity.

Light and ventilation voids are designed to increase the natural daylight levels and to enable air flow through the building. The configuration of the building enables it to operate in natural ventilation mode, during which the air-conditioning units is switched off and users can achieve the necessary comfort by opening windows and running ceiling fans. This strategy saves energy and helps to improve the quality of the indoor environment. The energy used by mechanical air conditioning is a major consumer of energy within a building. In a conventional building the mechanical air conditioning is designed to operate even with optimum outdoor conditions.

The configuration of the building enables it to operate in natural ventilation mode, during which the air conditioning plant is switched off and users can achieve comfort by opening windows. The ventilation voids enhance ventilation by providing breeze ways to direct fresh air throughout the building. If the outdoor conditions become favourable, the School's air conditioning plant will move into natural ventilation mode, during which time the air conditioning plant will shut down. Whilst in this mode, users can open the operable windows to control the temperature and air movement within the spaces to achieve a suitable level of thermal comfort. Reed switches have been installed on the window to ensure the air conditioning system does run whilst the windows are open.

The office and studio spaces have full mixed mode of natural ventilation and air conditioning as conditions require. There is individual control of spaces by the user with individual AC units, operable windows (in the studios) and ceiling fans. The circulation spaces have been designed to be naturally ventilated. To assist in the indoor air quality nearly 95% of all paint, adhesives, sealants, carpets and other floor finishes, are low VOC emitting. Similarly, 95% of all tables, chairs, and desks are recycled and no composite wood products were used in the project.

Lighting voids in the building increase the natural daylight levels by enabling light to penetrate through the floors from the clerestory roof above. In a conventional building, these areas would be lit with artificial lighting. As a result, the clerestory roof and strategically positioned light voids save substantial amounts of lighting energy.

The building services noise level meets the recommended design sound levels provided in Standards Australia (2000), the Australian Standard 2107:2000. Occupants are provided with an enhanced connection to the outside environment, thus promoting a healthier and more productive working environment.

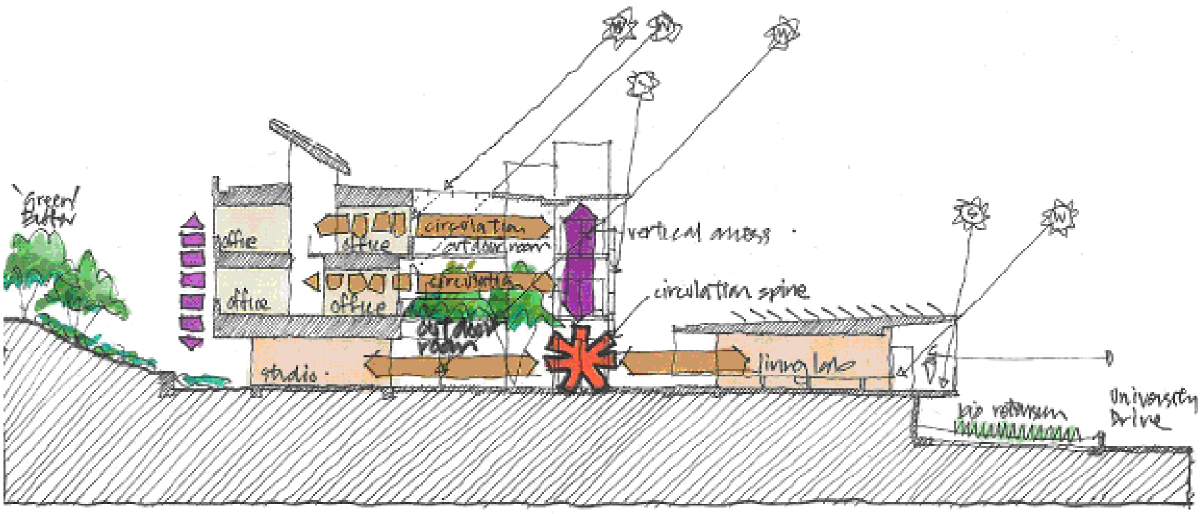
4. Day Light Strategy

Over 60% of usable floor area (UFA) achieves a 2.5% daylight factor and glare reduced through extensive external shading. All of the UFA has a direct line of sight to the external environment.

Lighting is controlled by photo-electric cells and supplemented with task lighting. High frequency ballasts were installed in fluorescent luminaires over a minimum of 95% of the UFA. The facility lighting design provides a maintenance illuminance of no more than 25% above those recommended in Standards Australia (1997), Australian Standard 1680.2.3 (Educational and training facilities) for 95% of the UFA.

The Daylight and ventilation strategy is illustrated in Drawing 1.

Drawing 1
Ventilation and Daylight



Source: Mirvac and Arup Sustainability (Australia)

5. Energy

The design reduces the energy consumption and greenhouse gas emissions of the base building compared to a conventional benchmark building as follows:

- Bond University School of Sustainable Development will produce 19,800 kg CO2/year;
- This compares to a benchmark of 113,252 kg CO2/year, which is an 82% reduction.

Submeters are provided to monitor both lighting and general power consumption. The submeters are connected to the BMS and continually demonstrate actual performance against energy benchmarks.

Energy demand reduction systems are installed to reduce peak demand on electricity infrastructure by 40%. This has been achieved by onsite generation.

There is one highly visible, internal stairs with good day lighting and these are provided in a strategic location as an alternative to using the lift. Services to each space automatically shut down when not in use.

All spaces have individual light switches and switching is clearly labelled and easily accessible by building occupants. An automated lighting control, including occupant detection and daylight adjustment, is provided.

The School's window shading structure have been carefully designed to block direct sunlight and in doing so, enhance the building's energy and comfort performance. The shade on the northern side of the building mainly consists of the large pergola structure, which lets in diffused sunlight but protects the building when the sun is at its highest, particularly during summer. On the east and west facades, the windows are protected by vertical shading which keeps the sun off during the early morning and late afternoon. On the southern side, vertical shades have been utilized to block direct sunlight, particularly late in the day.

High performance glazing has been included throughout the School to minimise the thermal heat gains and maximise the natural daylight into the building. Due to the pathway of the sun, the east and west facades of the building have the highest solar heat gains. To minimise the solar heat gains on these sides, high performance glazing with high U-values and low shading co-efficient have been installed.

The glass types throughout the school have been chosen with a high visual light transmission value. The high visual light transmission value increases the amount of natural daylight, reducing the need for artificial lighting.

Like most of Australia, the Gold Coast enjoys an excellent solar resource. The photo-voltaic cells solar system has a rated peak of 18 kilowatts and should produce around 13,500 kilowatt-hours per year, which is enough to provide the energy needs for two average homes. The system is grid-connected which means that the school can take advantage of the solar energy whenever it is being produced and is always able to import the balance of its energy needs. The solar energy replaces energy which would otherwise be produces by coal-fired power stations, thereby reducing the school's carbon footprint.

The Building Management System (BMS) monitors the outdoor conditions using a local weather station. When the outdoor conditions are optimum, the BMS disables the air conditioning system and notifies the occupant that the building is in natural ventilation mode. The occupant is notified of natural ventilation mode via display panels, positioned in various locations around the building. When the BMS determines that the outside climatic conditions are outside the comfort zone for occupants, or there is excessive wind or rain the air conditioning is enabled. Once the BMS has reactivated the mechanical system the occupants can elect to continue in natural ventilation mode, and supplement the natural ventilation with ceiling fans. Or alternatively occupants may wish to close the windows and activate the air conditioning system.

All offices and teaching spaces have high level operable window that can remain open when the space is unoccupied. This stops the space from over heating and reduces the need to use air conditioning to cool the room down when the occupants return.

6. Transport

The number of car parking spaces provided on the site was significantly reduced. Only two spaces are provided. All parking spaces are designed and labelled for small cars. The parking space is dedicated solely for use by carpool participants, hybrid or other alternative fuel vehicles.

Secure, undercover storage is provided for 10 student bicycles. In addition, lockable, undercover storage is provided for 5 staff bicycles. Showers, changing facilities and lockers are provided for cyclists.

7. Water

Rain water is collected on site and used for toilet flushing. The grey water is treated on site and as a result it reduces the overall flow to sewer by 52%. Potable water usage reduced by water efficient fixtures / fittings.

Water meters are provided to all major water uses. This is then monitored by the Building Management System. The landscape irrigation is sourced from rainwater and recycled water collected on site. The fire protection system tests water and maintenance draindowns collected and reuse onsite. Storm water run off treated on site prior to discharge.

Grey water is collected from 20 hand basins, 5 bathrooms/washrooms and 20 domestic sinks within the building. It then gravitates into a 15KL precast concrete underground tank. Although grey water is technically not 'recycled water' in as much as it does not emanate from sewage, it is being treated in the water treatment plant to Class A standard.

The building has been designed to collect rainwater from the building roof. The collected water is drained from the roof and is stored in three x 22.5KL precast concrete rainwater holding tanks. The collected water is then pumped back into the building where it is used to flush the toilets and urinals. The excess rainwater not used within the building, but is pumped into three 45KL polyethylene irrigation holding tanks. This excess rainwater is then used for sub-surface irrigation to the surrounding landscape.

8. Materials

All timber products used in the building and construction works were sourced from either postconsumer reused timber or Forest Stewardship Council (FSC) certified Timber. No composite wood products were used in the project. The recycled timber flooring used in the project has a reduced environmental impact.

Nearly 95% of the stainless steel joinery used in the project is new and has been designed to be modular and easily disassembled for future reuse. Loose furniture used in the project was recycled from other parts of the University. Over 95% of all paint, adhesives, sealants, carpets and other floor finishes, are low Volatile Organic Compounds (VOC). Nearly 95% of all tables, chairs, and desks are recycled. The total PVC content cost for major services elements was reduced by 96% (by cost) and in excess of 50% of the structural framing, roofing and façade cladding systems are designed for disassembly. In fact, the building exceeds the Green Star benchmark for PVC minimisation. The benchmarks in Mat6 are 30% and 60% reduction in PVC. Areas have been provided for the separation, collection and recycling of office consumables and waste. The concrete used in the building construction has 30% of cement replaced with an industrial waste product. However, the building was unable to achieve points for recycled materials (mainly plaster board) as these were mainly new materials. To encourage the reduction of embodied energy and resource depletion, all reinforcement steel supplied to the project has a post consumer recycled content of 100%. However, over 90% of construction waste by weight was reused or recycled.

9. Land Use and Ecology

The development site for the building is neither prime agricultural land nor land on or within 100m of a wetland. The ecological value of a development site was enhanced beyond its previously existing state primarily through the inclusion of an artificial wetland (a bio-retention basin).

The cut and fill excavation for the building were balanced on the campus and this meant that there was no exportation of topsoil from the immediate site.

The landscaping for this site comprises a mixture of predominantly native flowering plants and native hybrids. All plants within the landscape are commonly found and used throughout South East Queensland. The plants selected demonstrate that a drought tolerant landscape can be 'green' and colourful at the same time. Species were selected for their ability to cope with drought and the immediate site conditions around the building. The trees used within the building surrounds (under cover) have a cooling effect on the micro-climate, utilising breezes and providing a large amount of shade due to their grouping. Extensive use of landscape mounding has been used to the north of the site to eliminate strong south-easterly winds. The mounding has also been positioned to ensure natural light is not inhibited from entering the building.

A bio-retention basin has been constructed. This is a vegetative device that filters stormwater run-off through various layers of densely planted surface vegetation. The water then percolates through layers of filter media. A mixture of species types is vital to the success of the system. Plants assist in the removal of unwanted nutrients in the water and also ensure that oxygen reaches the soil which helps with the transformation of captured pollutants. Bio-retention systems operate best when water is allowed to pond and percolate through the filter media for approximately 3 days. This basin has been designed to capture and treat stormwater run-off for a 1-20 year flood event.

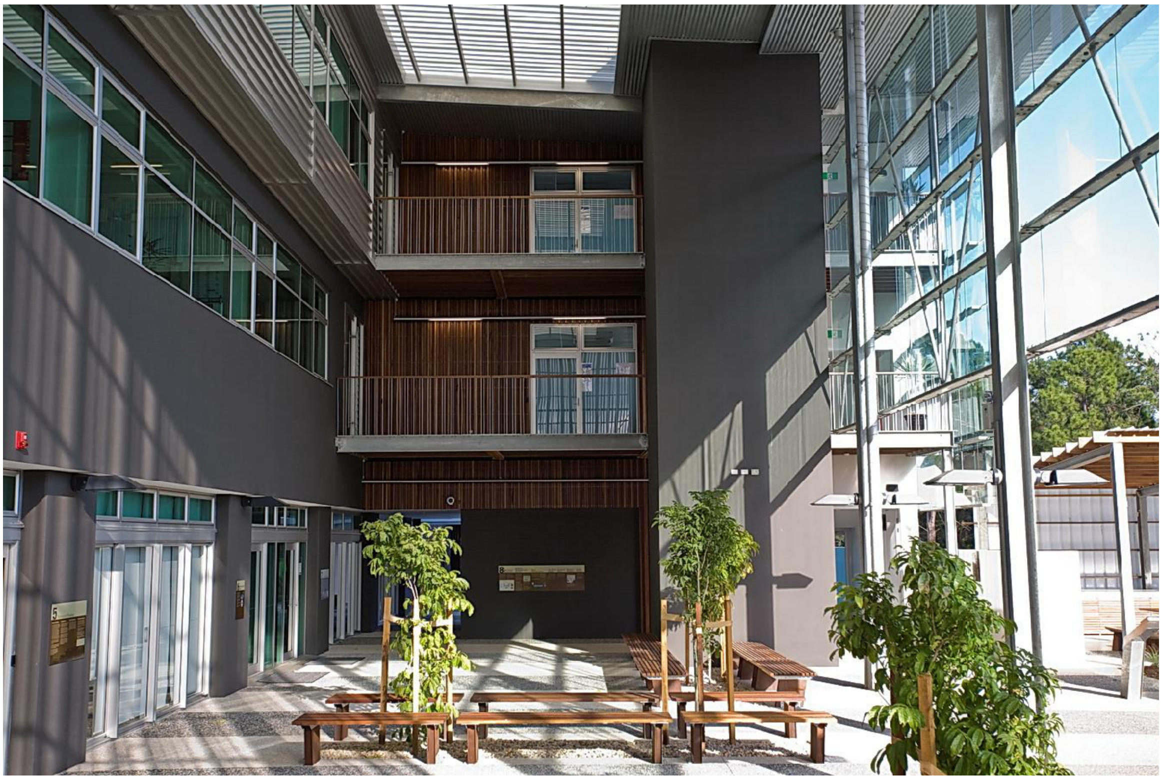
10. Innovation

The Green Star Main eight criteria required the inclusion of three education initiatives. This building has included 36 initiatives and the focal point of these is the dedicated 'Living Laboratory building'. This part of the building is designed specifically to show a significant increase in environmental education opportunities for the community. The Living Laboratory is intended to showcase various sustainability designs through educational displays. These displays will eventually be featured on numerous audio-visual screens, rolling videos and projection screens. The displays will also feature both real time and historical performance data extracted from the building management systems (BMS).

An innovation point was also awarded for the inclusion of an alternative lift technology which is not rewarded in the earlier tool criteria. The building has a regenerative drive lift that generates electricity on descent which is separately metered to provide detailed information on the actual benefit of such technology.

Photograph 2

Outdoor Room showing location of regenerative lift



Source: Mirvac

In a typical non-regenerative drive lift, energy is dissipated when the lift brakes. This results in reduces efficiency and additional waste-heat loads in the building. The regenerative drive lift feeds the excess energy back into the building's internal electrical utility where it can be re-used. The regenerative drive lift can result in an overall energy saving of 70%.

The other benefits of a regenerative drive lift are that it is environmentally friendly, it has a lower harmonic distortion (typically below 5%), has a reduced radio frequency interference, it provides significant cost savings, has smaller main cables and enjoys reduced power demands in peak periods.

The Weather Station (Vaisala Wind Set WA15) provides a reliable and high performance for wind and accurate meteorological measurements. The Weather Station is also connected to the Building Management System and is used to dictate whether or not the building is in 'natural ventilation mode'. If the climatic conditions are optimum outside then the Building Management System will automatically operate in natural ventilation mode. When this mode is activated, the air conditioning will automatically shut off, the high level windows will open and all occupants will be required to physically open their windows.

The wind turbine is another innovative feature that harnesses the energy in the wind to rotate a generator to produce electricity. The electricity generated by the wind turbine is consumed by the building. The turbine starts producing electricity when the wind blows at 4.0 m per second and reaches a maximum output at 11m per second. It has a rated peak power output of 1 kW. This wind turbine is expected to produce around 50 kilowatt-hours per year. At a windy site, it could produce 800 to 1,000 kilowatt-hours per year, or approximately one-eighth of the total energy consumption of an average house. However, the wind turbine is provided as an educational feature rather than an effective power generator.

11. Summary

Green Star Accredited Professionals have provided sustainability advice throughout the design and delivery period and a facilities management representative was included on the design team. Comprehensive pre-commissioning, commissioning, and quality monitoring was performed by the appropriate contractors and subcontractors. The design team and the contractor provided information and documentation to the building owner regarding design intent, as-installed details, commissioning reporting and training of building management staff.

The building is presently undergoing a 12-month commissioning / building tuning period. An independent commissioning agent has been appointed. A Building Users' Guide has been provided to all occupants of the building.

A site specific Environmental Management Plan (EMP) for the works has been prepared in accordance with the requirements of the Green Building Council. The building's environmental attributes are displayed in a manner that can be readily understood by building users. These are presented in thirteen information stations located at key points around the building and are part of the building tour conducted by staff in the school. The building tour aims to educate students and visitors about the ecologically sustainable attributes incorporated into the design and construction of the Mirvac School of Sustainable Development. An interactive tour map outlining the buildings sustainability attributes will be displayed on an LCD touch screen located within the building living laboratory.

A site tour map that outlines the viewing stations for each of the sustainability attributes is available from the living laboratory. The tour leads students through the site to strategically located viewing stations. Information boards will be located at each viewing station enabling students to learn about the sustainability attribute and its effect on the surrounding environment.

The staff are now becoming familiar with a building that needs 'driving' to make it provide the necessary conditions for activities to take place. For instance, occupants have to 'turn on' their office or teaching space to provide the necessary comfort and lighting conditions for those activities to take place. If the spaces are not 'keyed in' then the space remains inert and does not use wasteful energy. After overcoming this psychological barrier and often frustration, the staff are now familiar with the building's characteristics and explain these requirements to the unsuspecting visitor or newcomer. In fact, the building and the occupants now work as a team to minimise energy use whilst maximizing comfort conditions.

Acknowledgements

The Project Team

Client: *Bond University and Mirvac;* Contractor: *ADCO;* Architects: *Mirvac Design;* Sustainability: *ARUP Sustainability;* Services: Engineering: *Bassett;* Structural Engineer: *Qantec McWilliam;* Hydraulic Engineer: *Steve Paul and Partners;* Landscape Architect: *Aspect Studio;* Civil Engineer: *Waterway Solutions;* Building Surveyor: *McCarthy Consulting Group;* Quantity Surveyor: *Turner & Townsend Rawlinsons*

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